AERIAL BOMBING of FOREST FIRES

A progress report of an Experiment

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

AERIAL BOMBING

OF

FOREST FIRES

A PROGRESS REPORT OF AN EXPERIMENT

BY

THE ARMY AIR FORCES
AND
THE U. S. FOREST SERVICE

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AERIAL BOMBING OF FOREST FIRES

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Foreword

The Army Air Forces and the U. S. Forest Service with special assistance from the National Bureau of Standards are engaged in a research project to study and develop aerial bombing for employment against small forest fires. This progress report is issued to present preliminary information on this activity to interested agencies. Upon completion of the present research project more complete reports will be issued jointly by the Army Air Forces and the U. S. Forest Service.

Purpose

This first "pilot plant" test of retarding the spread of small forest fires by bombing them with water or chemicals is purely experimental. This is a research job designed to find out what will happen when bombs are dropped on small, hot fires burning in rough, mountainous country. The test program is divided into four phases:

1. Development of bombing equipment and techniques.

2. Development of bombing accuracy under various conditions of forest cover and topography.

3. Determination of effects of water and chemical filled bombs on fires burning in various fuels and under various weather conditions.

4. Development of operational techniques.

Background

The idea of bombing forest fires is not new. More than 15 years ago the Forest Service Fire Chief of the Northern Region, Howard Flint, kicked a beer keg full of water out the door of an airplane flying over Felts Field, Spokane. He wanted to see how much area would be covered by the splash. The result was not promising. Five-gallon cans filled with water were then tried, and at the Johnson Brothers Airport at Missoula large paper bags filled with foamite were thrown at the perimeter of a 50-foot circle drawn on the ground to simulate the perimeter of a forest fire. Still other tests with various containers and fillings were conducted by the Forest Service in California.

These preliminary tests showed:

1. That bigger bombs with good ballistics were needed.

2. That airplanes with greater carrying capacity were required to drop the bombs.

3. That precision bombing equipment was needed to hit small fires accurately.

In the years prior to the war none of these requirements could be met. Nevertheless the idea of bombing fires persisted, especially in the Northern Region where foresters visualized that vast stands of valuable timber in remote, mountainous country required extraordinary measures for protection. Mr. David Godwin, Chief of Fire Control for the U. S. Forest Service until his untimely death in an airplane accident in May 1947, was one of those farsighted men who kept watching for chances of surmounting the obstacles to aerial bombing. The war stopped Forest Service development in this field, but the war also brought development by the military forces of the things which early tests showed were needed to bomb forest fires. Large bombs, the airplanes to carry them, and precision bombing equipment were developed on an unprecedented scale. Shortly after V-J Day Mr. Godwin renewed his efforts for aerial bombing experiments and in November 1945 succeeded in effecting a cooperative agreement with the Army Air Forces to start the work.

Many other Forest Service fire control developments are allied to the requirements for aerial bombing. The Forest Service has made great strides in the use of airplanes and has gained valuable experience in their capabilities and limitations. Aerial delivery of equipment and supplies to fire fighters has become a common event. Smokejumpers parachuting down from planes are proving very successful against back-country fires. More recently aerial detection has been expanded to supplement, and in some cases to replace ground observers. The possible use of helicopters for many fire jobs may not be far in the future.

These aerial developments have been aimed primarily at speed in fire control, following the principle that the quicker a fire is controlled the lower the resultant cost and damage. But these aerial developments have not changed the basic methods of fire suppression. Although the smokejumper now gets to a fire quicker, upon arrival he is still a hand-tool fire fighter depending mainly upon a Pulaski tool and shovel just the same as the ground traveling smokechaser. Foresters all realize that some small, hot fires burning in tough fuels get away because the hand-tool fire fighter can't cope with them. If aerial bombing can be developed successfully, a method will be provided whereby such fires can be knocked down and retarded with large volumes of aerially delivered water and chemicals. Then the job of finishing up on these fires can be handled rather easily by conventional methods.

One job done before the war by the Forest Service Branch of Research may aid the present bombing project. This was the testing of fire extinguishing chemicals at various Forest Experiment Stations throughout the country and at the Forest Products Laboratory. At our own Priest River Experimental Forest in northern Idaho we found that on heavy fuels like branchwood, dead and down trees or snags, available chemicals were not appreciably superior to water on a weight-for-weight basis when applied from hand-driven pumps. Tests made by the Forest Products Laboratory showed which chemicals appear most promising. As a result ammonium phosphate solution and fortified foam will be used as bomb fillings in the present experiment. Project personnel will make careful investigations of the possibility that aerial bursts of these substances over a fire may present a method of application which offers new possibilities for chemicals.

Army Air Forces

Army Air Force participation in this research project is under the jurisdiction of the Air Proving Ground Command at Eglin Field, Florida. This Command is responsible for the testing of all AAF equipment for tactical use. By virtue of its assigned mission, equipment, personnel, and experience, the Air Proving Ground Command is expertly qualified to perform the required tests of forest fire bombing.

Initial AAF work on the project was performed at Eglin Field where studies and tests were made of bombs, bombing equipment and military airplanes suitable for employment against small fires on flat topography. During these tests various bombs were dropped from several types of aircraft. As a result it was determined that with a slight modification of bomb racks the B-29 Superfortress could carry eight 165-gallon tanks to be used as water bombs and that standard fighter planes such as the P-47 Thunderbolt could make glide bombing runs dropping two of these tanks. With this preliminary work completed the AAF moved the experiment to Montana to commence critical tests under field conditions.

The Air Proving Ground detachment is based at the Great Falls Army Air Base. Under the command of 1st Lt. Charles G. Mathison, some 30 officers and men are devoting full time to the field tests. One B-29, now named "The Rocky Mountain Ranger", and two P-47 Thunderbolt fighters are assigned to the project for bombing fires. Plate 1 shows the B-29 and the Air Forces crew. Plate 2 shows a P-47 and the process of filling one wing bomb. In addition a B-25 bomber is used on the project as a liaison plane. Air Ordnance Officer, 1st Lt. R. A. Duffy, has been assigned to the Forest Experiment Station at Missoula to assist in technical details of bomb modification and evaluation of bomb performance in the field test area. Most recently Lt. Colonel M. H. Keilman has joined the Missoula staff.

Bombs

One essential phase of this project is to determine the types of bombs most suitable for forest fire suppression. To date a hundred of the 165-gallon tanks have been dropped from the B-29 and the two P-47's. These tanks are war surplus material. They were used in the war by fighter planes to extend their gasoline supply to cover longer range missions. The tanks were then jettisoned. The tanks dropped from the B-29 are modified in the Forest Service engineering shops at Missoula to include a tail fin, a burster well for an explosive charge, a nose adapter for the fuse, and carrying lugs for various positions on the bomb racks. Two of the steps in modification are illustrated in Plates 3 and 4. A few tanks, equipped the same way but with tail fins positioned at a different angle, were prepared for use in dive bombing by the P-47's. However, this method of bombing in rough, mountainous country has not proved feasible. Therefore, unstabilized 165-gallon tanks are now being used by the fighters and are delivered from a glide rather than a dive bombing run. This lowers the cost of modification appreciably.

Results to date indicate that the bombs dropped from the B-29 should either be very large containers with precision ballistics, or that large numbers of smaller containers should be laid down in a tight pattern on and around a fire. Aerial bursting of these containers is desirable, both to prevent cratering and to disperse the extinguishing liquid more widely over the fire area. The modified 165-gallon tanks have shown some promising characteristics for this purpose, but the tests to date have not been conclusive. The ability to make a truly precision bomb out of a 165-gallon tank is a challenging problem for future work.

Other types of bombs are also being tested for forest fire use. These include the Army M-56, 4000-pound light case bomb; the E-36, 500-pound experimental chemical bomb, and the M-47A3, 100-pound chemical bomb. The M-56 and E-36 bombs are intended for aerial burst. The M-47A3 bombs will be fused for impact burst. The latter type bomb will be dropped in clusters from the B-29 which is capable of carrying a total load of 184 individual bombs. It is desired to test such bombs to study the possibilities of laying down a pattern on and around a fire.

Figure A. Christening of the Rocky Mountain Ranger at Great Falls, Mont., July 22, 1947. Col. H. L. Donicht, Mayor Jahlmar Johnson, Dana Parkinson, Regional Forester P. D. Hanson, Lt. Col. R. O. Good, and Project Leader J. S. Barrows of the Northern Rocky Mountain Forest and Range Experiment Station.

Figure B. The Air Forces crew assigned to the Aerial Bombing Project.

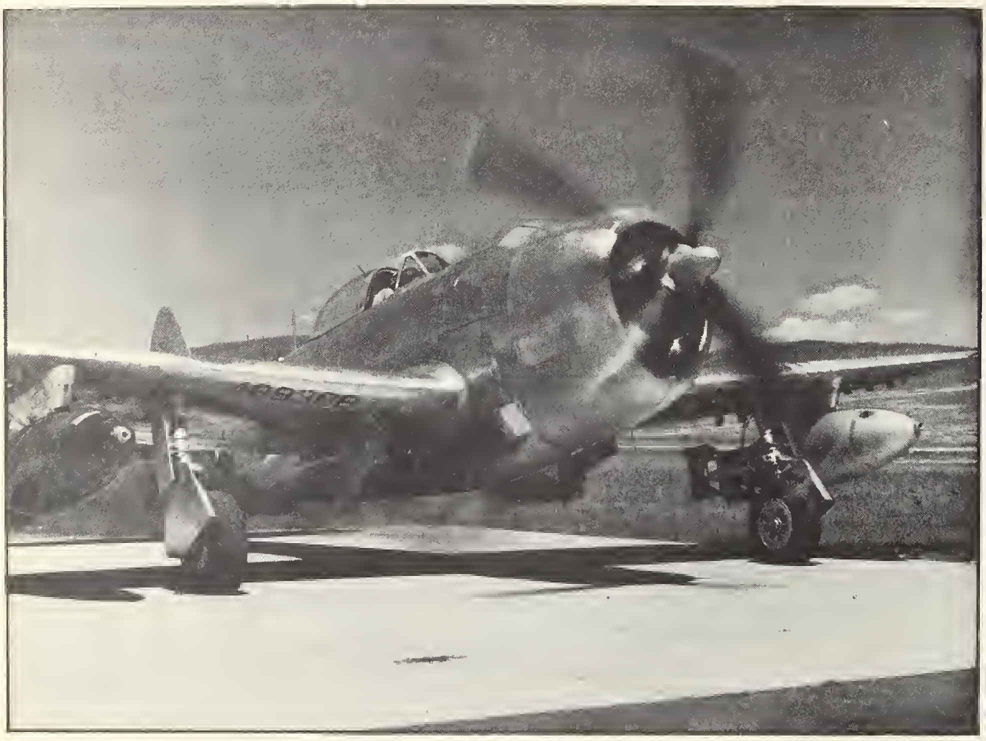


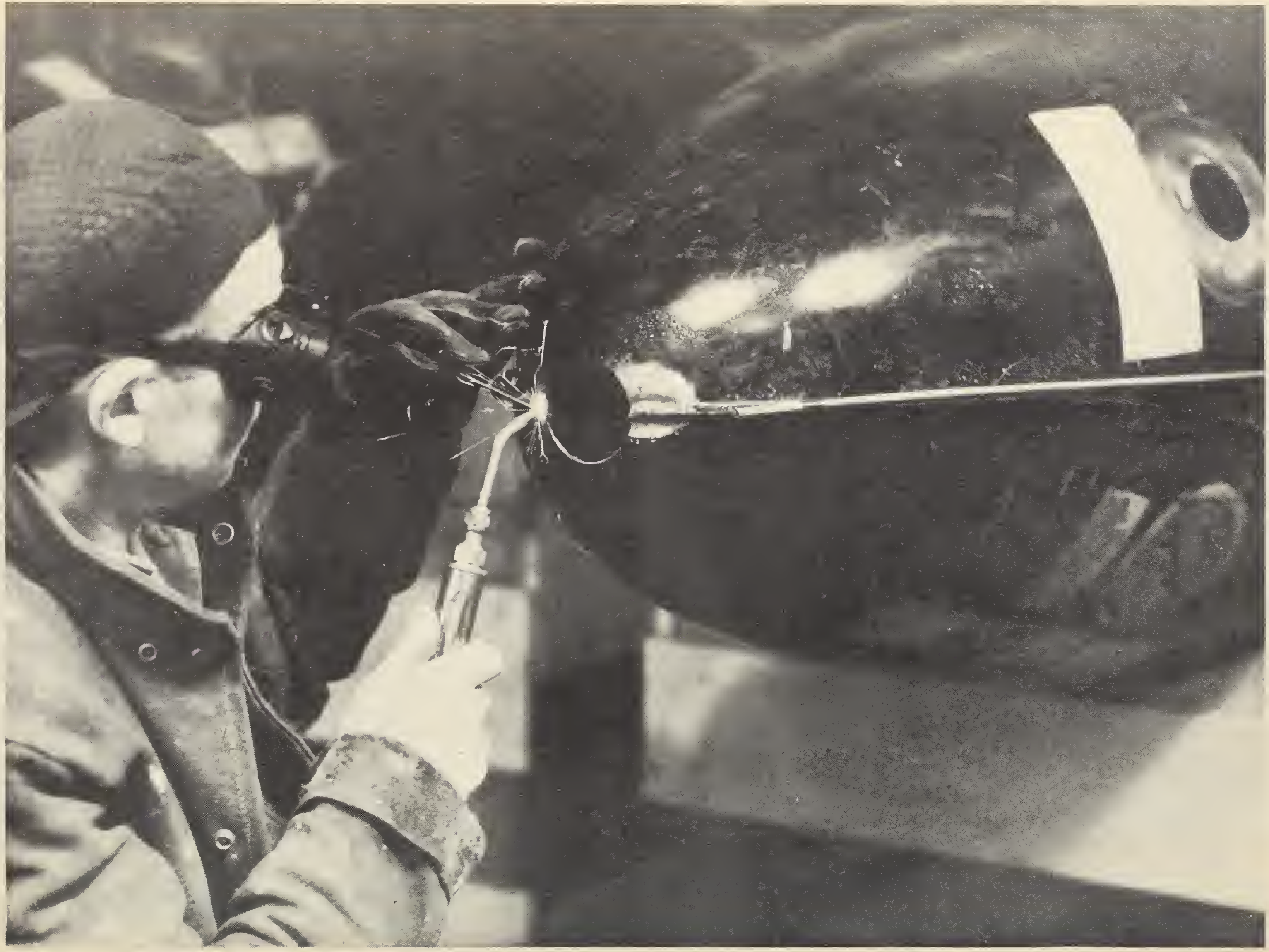
Figure A. A P-47, with two stabilized bombs, ready to take off for a fire.

Figure B. Filling one of the 165-gallon bombs on a P-47.

Plate 3

Fitting tail fins to the 165-gallon tanks to
give them more bomb-like ballistic qualities.

Plate 4



Cutting a hole in the nose of a 165-gallon tank to insert a bursting charge of TNT.

Experimental Procedures

An area in the Lolo National Forest, containing a wide variety of fuel and topographic conditions, is being used as a bombing laboratory. Fires are set in this area as targets for the bombs, as shown by figures A and B of Plate 5. On each test fire Forest Service technicians make detailed measurements and observations, including rate of spread before and after bombing, weather factors, burst height, water dispersion pattern, etc. These data are obtained to determine the effects of the bombs on the rate of spread and burning characteristics of the fire. In addition each fire bombed is a test of airplane equipment and accuracy as well as providing essential practice for the pilots and bombardiers.

These experimental bombing missions involve many detailed operations. Both air and ground crews are briefed on procedures prior to the mission. During bomb runs constant communication and control between the airplanes and the ground observers is maintained by means of radio. Each bomb is numbered and its point of impact and pattern is drawn on a map. Reports to be used in bombing evaluation studies are prepared by both air and ground crews. Most recent operations include the setting of pairs of fires, one bombed and the other allowed to burn as a "check plot" or comparison.

When the experiment has progressed far enough to yield basic information on both bomb performance and effect on fires it is planned to bomb actual fires. This phase of the test program will permit study of desirable operational procedures. Obviously such tests are premature until certain basic information now being sought is obtained. However, it is recognized that the final pay-off of bombing must be made against real fires. Determining what fires to bomb, when and where to bomb, how to direct the bombers to particular fires, ability to recognize the target, and aerial evaluation of results are all factors to be studied in later phases of the test program.

Results to Date

The first "results" of this experiment were obtained at Eglin Field, Florida, where the Army Air Forces found that fires in easy fuels on flat topography could be materially slowed down or almost extinguished by aerial bombing. These tests also showed that both the B-29 and the P-47 were good planes for this purpose.

Results since transferring the tests to the heavier fuels and the rougher topography of the northern Rocky Mountains have been equally promising. Direct hits and highly beneficial "near-misses" have been scored time after time by both types of planes. Plate 5 shows two B-29 bombs each bursting 165-gallon tanks so close to the test fires that the smoke of these fires is obscured in the photograph by the great belches of water. Plate 6 shows in figure A the outline or pattern of an obviously beneficial near-miss by two bombs dropped simultaneously by a P-47. Figure B of Plate 6 shows a direct hit on this same fire, only a few minutes later, by a second P-47 cargo of two bombs.

Accuracy of aim at fires in less accessible spots, i.e., in the bottoms or on the steep sides of deep canyons, remains to be determined. But pilots Stewart and Lampart of the P-47's, and pilot Mathison and bombardier Trimble of the B-29 are confident that with more experience, more practice, and with ballistically better bombs they can do equally well in all but our most extreme box-canyons.

Results to date can therefore be labelled as definitely promising.

Potentialities

The principle objective in the present aerial bombing experiment is to knock down and retard the spread of small, hot fires before they can make a disastrous run. If these fires can be merely slowed down so that control by available smokejumpers or ground forces can then be assured the benefits are obvious. The potential saving in cost of fire control is evident from data compiled in a previous study of fire control efficiency. These data show that an average fire controlled within 24 hours after origin costs about $700. However, if this fire escapes immediate control it can be expected to spread within the next 24 hours to such size that the cost of control will jump up to about $2,800. And if it escapes second day control, so that it cannot be suppressed until the third day after origin, the expectable cost of control will skyrocket to more than $5,000. These figures are based upon pre-war costs and do not reveal the "inflation" in current fire control costs.

It should be noted that these costs are for the average fire controlled in time intervals shown. The worst fires, starting in the worst fuel types on the worst fire days obviously are the ones which most often escape immediate control and therefore produce truly extreme costs.

As one example of the really great savings which MAY be made as a result of aerial bombing the million dollar Pete King and McLendon Butte fires should be recalled. These two fires, which were fought almost as if they were one because of their proximity, burned a total of some 240,000 acres on the Selway National Forest in northern Idaho during the critical fire season of 1934. More than 5,000 men were employed, distributed at 74 different fire camps, from which they built 410 miles of fire line, largely by use of hand tools. More than 100 trucks and travel cars were driven some 233,000 miles to supply these fire camps with tools, food, bedding, and other supplies. Four hundred and seventy-five head of packstock were used to transport the supplies from the ends of the roads to the fire camps in the back country. The total suppression cost was a little over a million dollars, not to mention the timber, wildlife, watershed, and other values that were destroyed.

The several lightning fires, which included the Pete King and McLendon Butte, and which finally burned together to cause this great expense, originated during the night of August 10-11, 1934. They started from dry and unpredicted lightning storms in what foresters call "bad fuels", i.e., an old burn which had left great quantities of dead wood on the ground. The area was "dry as a bone." From June 27 to August 11, a period of 46 days,

Figure A. 165 gallons of water about to deluge a fire beneath it.

Figure B. The outrushing cascade of water from a bomb burst 50 feet above ground in a timber stand.

Figure A. The pattern (outlined in white) covered by two bombs dropped by a P-47. (This pattern shows clearly on the original photograph.)

Figure B. A direct hit on the same fire by a second P-47.

no weather station within this area had recorded a single rain of more than 0.20 inch, an amount which fire research has found must be exceeded if it is to reduce fire danger materially. For the last several days before August 11, measurements of fire danger within this area had shown that near explosive conditions prevailed.

By 5:15 o'clock in the morning of August 11, after 31 new fires had been reported as originating in this general protection district since 3:00 a.m., action was started by the 15 to 20 forest officers and some 1000 CCC and other fire fighters available within a 50-mile radius. Although some of these men were just finishing the control of other, previous fires they were immediately "pulled" and dispatched to the most threatening new ones. Certain of these new ones were known to be in bad fuels, most of them many miles away from any road, and some of them several miles from the nearest trail. The coming day, August 11, was expected to be a bad fire day. It usually is, following dry lightning storms.

Suffice to say, that with all this knowledge and despite the fast and excellent action in dispatching men, two of these new fires "blew up." These two literally exploded in the faces of the first few firefighters to reach them. Within a few hours they were throwing spot fires and were beyond control until the cool, calm air of nighttime arrived.

As is evident, here was a chance for aerial bombing. With locations of the fires known by 5:00 a.m., there would have been time to call for the bombers and time for the bombers to fly, even from Great Falls, Montana, to the area before these fires began to pick up and run. In the cool, heavy, and stable air of early morning, bombing conditions would have been ideal. The two fires that escaped early control and blew up in the heat of the day would have been obvious to an experienced pilot and bombardier. A few well placed bombs would have slowed these fires appreciably. There might have been time, if necessary, for the bombers to have flown back to Spokane for a second and even a third load of bombs. The Selway Forest is only 140 miles or 30 minutes by air from Spokane.

What might have happened had we had bombers on this fire is, of course, mere conjecture. But the circumstances were such that certain assumptions seem reasonable. It seems obvious, for example, that should such conditions recur next year, and should we be ready with aerial bombing facilities and techniques, this new method of fire control MIGHT save a million dollars in one fell swoop.

Before this can be done, however, the present experimental project must be carried through with meticulous care to maintain an objective attitude and to make a thoroughly scientific analysis of every feature. That is our intention. The economic aspects must, of course, await examination until after mechanical feasibility has been thoroughly tested.